UNIVERSITI SAINS MALAYSIA

Second Semester Examination
Academic Session 2008/2009

April/May 2009

EBP 412/3 – Specialty Engineering Polymers
[Polimer Kejuruteraan Khusus]

Duration : 3 hours
[Masa : 3 jam]

Please ensure that this examination paper contains TWELVE printed pages before you begin the examination.
[Sila pastikan bahawa kertas peperiksaan ini mengandungi DUA BELAS muka surat yang bercetak sebelum anda memulakan peperiksaan ini.]

This paper contains SEVEN questions.
[Kertas soalan ini mengandungi TUJUH soalan.]

Instruction: Answer **FIVE** questions. If candidate answers more than five questions only the first five questions answered in the answer script would be examined.
*[**Arahan**: Jawab **LIMA** soalan. Jika calon menjawab lebih daripada lima soalan hanya lima soalan pertama mengikut susunan dalam skrip jawapan akan diberi markah.]*

Answer to any question must start on a new page.
[Mulakan jawapan anda untuk setiap soalan pada muka surat yang baru.]

You may answer a question either in Bahasa Malaysia or in English.
[Anda dibenarkan menjawab soalan sama ada dalam Bahasa Malaysia atau Bahasa Inggeris.]

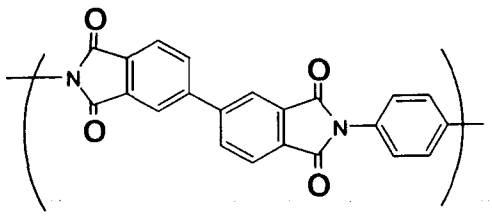
1. [a] Describe what is meant by birefringence.

Perihalkan apakah yang dimaksudkan dengan 'birefringence'.

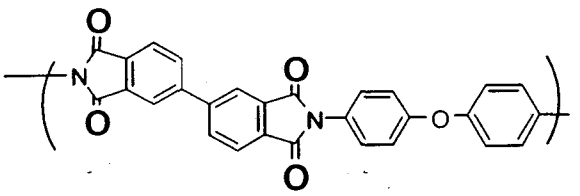
(25 marks/*markah*)

[b] Explain why two polyimide, A and B, as shown below display different birefringence property. What is the effect on the birefringence property in mixing them together at equal mole ratio?

Jelaskan kenapa dua poliimida, A dan B, seperti ditunjukkan di bawah mempamerkan sifat 'birefringence' yang berbeza. Apakah kesannya jika keduanya dicampurkan pada nisbah mol yang sama terhadap sifat 'birefringence'?



A



B

(40 marks/*markah*)

[c] Describe the working mechanism of liquid crystal display (LCD).

Perihalkan mekanisme kerja bagi Layar Hablur Cecair LCD.

(35 marks/*markah*)

2. [a] What is doping and how does it affect conduction mechanism in polymers.

Apakah 'doping' dan bagaimana ia mempengaruhi mekanisme kekonduksian polimer.

(30 marks/*markah*)

[b] Electrical conductivity in polymer could occur through π-conjugation and hoping. Describe one of these mechanisms.

Kekonduksian elektrik dalam polimer boleh berlaku secara konjugat-π dan lompatan. Jelaskan salah satu mekanisme ini.

(30 marks/*markah*)

[c] Based on the table below, discuss the effects of temperature and *d*-spacing of a crystal indices on conductivity of polypyrrole.

Berdasarkan jadual di bawah, bincangkan kesan suhu dan jarak d pada satah hablur terhadap kekonduksian polipirrol.

Temp / *Suhu* C	2θ	$d_{spacing}$/Å	Conductivity / *Konduktiviti* S/cm
1.2	25.5	3.49	26.26
9.8	25.0	3.56	16.65
16.8	23.5	3.78	12.96
35.4	22.5	3.94	2.81
45.9	22.5	3.94	0.22
59.8	22.5	3.94	0.04

(40 marks/*markah*)

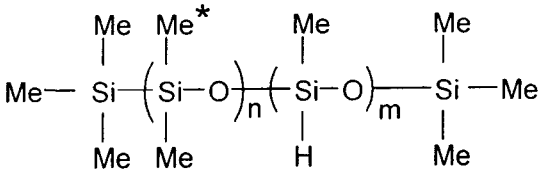
3. [a] List 3 properties required for a polymer to be used as LED encapsulant.

Senaraikan 3 ciri yang perlu bagi suatu polimer untuk kegunaan penyalut LED.

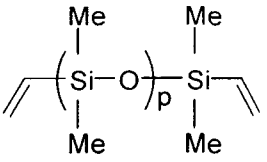
(25 marks/*markah*)

[b] Thermal curing of silicon using platinum catalyst for encapsulation application involve Part A and Part B as shown below. Suggest the cross-link network that is formed during the curing.

Pematangan termal silikon menggunakan mangkin platinum bagi kegunaan penyalutan melibatkan Bahagian A dan Bahagian B seperti yang ditunjukkan di bawah. Cadangkan rangkaian sambung-silang yang akan terbentuk semasa pematangan ini.



Part A / *Bahagian A*



Part B / *Bahagian B*

(35 marks/*markah*)

[c] The table below shows specification for cured encapsulant derived from Part A and Part B from question 3 [b]:

Jadual di bawah menunjukkan spesifikasi bagi penyalut termatang yang diperolehi dari Bahagian A dan Bahagian B soalan 3 [b]:

Viscosity at 25 °C / *Kelikatan pada 25 °C*	3000 – 4000 cps
Refractive Index / *Indeks Pembelauan*	> 1.43
Hardness / *Kekerasan*	Shore A 40 - 50
Standard cure time / *Masa pematangan piawai*	150 °C/hr

Based on these specifications, please answer any two of the followings:

(i) Why do the viscosity need to be in the range 3000 – 4000 cps.

(ii) Suggest the effect of increasing the value of *n* on the hardness.

(iii) Suggest the effect of replacing the methyl group (denoted as Me*) above with phenyl ring on the refractive index.

Berdasarkan spesifikasi ini, jawab 2 dari yang berikut:

(i) Mengapakah kelikatan diperlukan dalam julat 3000 – 4000 cps.

(ii) Cadangkan kesan peningkatan nilai n terhadap kekerasan.

(iii) Cadangkan kesan penukargantian kumpulan metil (bertanda Me) dengan kumpulan fenil terhadap indeks pembelauan.*

(40 marks/*markah*)

4. [a] Discuss 3 factors which need to be taken into account when selecting polymer for medical use.

Bincangkan 3 faktor yang perlu dipertimbangkan apabila memilih polimer bagi kegunaan perubatan.

(30 marks/*markah*)

[b] Describe the mechanism of degradation of PCL/PLLA during drug delivery application.

Perihalkan mekanisme degradasi PCL/PLLA semasa penggunaan di dalam penghantaran "drug".

(35 marks/*markah*)

[c] Polyethylene is a commercial polymer having low tensile strength and wear resistance. Suggest 2 methods to utilize this polymer for orthopedic application.

Polietilena adalah polimer jenis komersial yang umumnya mempunyai sifat tensil dan rintangan lelasan yang rendah. Cadangkan 2 kaedah yang boleh diambil supaya polimer ini sesuai bagi penggunaan ortopedik.

(35 marks/*markah*)

5. [a] What is photolithography and describe the role of polymer in this process.

Apakah fotolitografi dan jelaskan peranan polimer dalam proses ini.

(25 marks/*markah*)

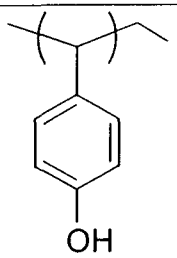
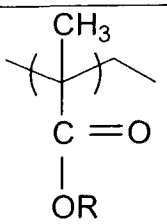
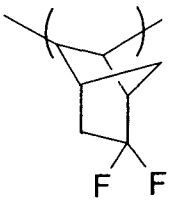
[b] What is the difference between positive and negative photoresist?

Apakah perbezaan antara "fotoresist" positif dan "fotoresist" negatif?

(30 marks/*markah*)

[c] The table below shows photoresists applied at different wavelength during photolithographic process.

Jadual di bawah menunjukkan "fotoresist" yang digunakan pada berbagai jarak gelombang pancaran semasa proses fotolitografi.

	A	B	C
Photoresist / *Fotoresist*			
Wavelength / *Gelombang pancaran* (nm)	248	193	157

(i) What is the effect of reducing the wavelength of radiation during this process on Integrated Circuit (IC) fabrication?

Apakah kesan pengurangan jarakgelombang sinaran dalam proses ini semasa fabrikasi Litar Tersepadu (IC)?

(ii) Why the polyhydroxystyrene is not used at a radiation below 248 nm?

Mengapa polihidroksistirena tidak digunakan pada sinaran kurang dari 248 nm?

(iii) What is the effect of fluorin in photoresist C during photolitografic process?

Apakah kesan unsur florin dalam "fotoresist" C semasa proses fotolitografi?

(45 marks/*markah*)

6. [a] Draw chemical structure for:

(i) Polychlorotrifluoroethylene

(ii) Polyvinylidene fluoride

(iii) Fluorinated ethylene-propylene copolymer

Lukiskan struktur kimia bagi:

(i) Poliklorotrifloroetilena

(ii) Polivinilidena florida

(iii) Kopolimer etilena-propilena terflorin

(21 marks/*markah*)

[b] Why is PTFE have very low coefficient of friction?

Mengapakah PTFE mempunyai koefisien geseran yang sangat rendah?

(35 marks/*markah*)

[c] PTFE undergoes several crystallographic changes during thermal treatment. Based on the DMA analysis of a PTFE film as shown below, answer the following:

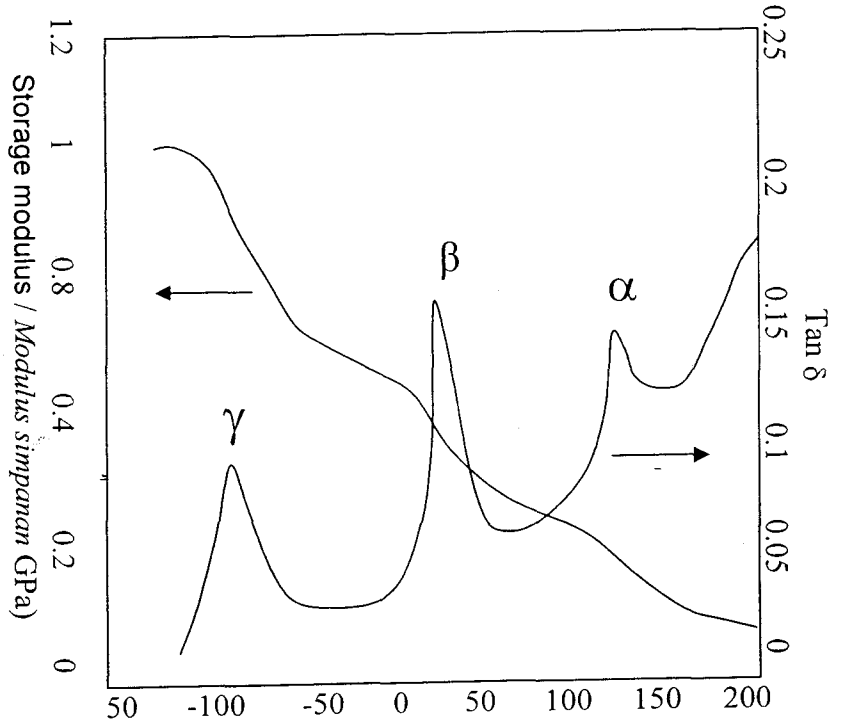
(i) What does the thermal transition α, β and γ represent?

(ii) Describe the change in conformation of this polymer in terms of storage modulus as the temperature is increased.

PTFE mengalami beberapa perubahan kristolografi semasa rawatan haba. Berdasarkan analisis DMA bagi filem PTFE yang ditunjukkan di bawah, jawab soalan berikut:

(i) Apakah yang diwakili oleh perubahan termal α, β dan γ?

(ii) Bincangkan perubahan konformasi polimer ini berdasarkan modulus simpanan apabila suhu ditingkatkan.



(44 marks/*markah*)

7. [a] What is spin coating?

Apakah yang dimaksudkan dengan penglitupan putaran?

(20 marks/*markah*)

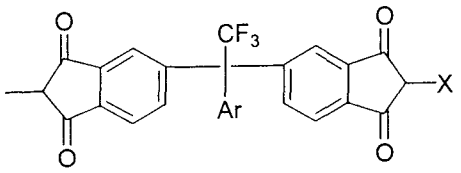
[b] Suggest 3 strategies to reduce the dielectric constant of polyimide.

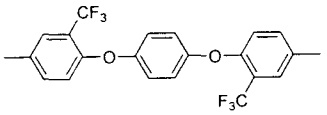
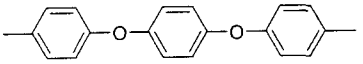
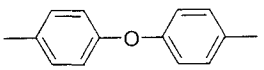
Cadangkan 3 strategi untuk mengurangkan nilai pemalar dielektrik bagi poliimida.

(36 marks/*markah*)

[c] The variation of glass transition and coefficient of thermal expansion for polyimide with X structure is indicated in the table below.

Perubahan nilai peralihan kaca dan koefisien bagi pengembangan termal untuk poliimida dengan struktur X adalah ditunjukkan dalam jadual dibawah:



X			
Tg(°C)	245	265	285
CTE ($!0^{-5}$/ K)	58	57	56

Suggest a reason for the increasing trend in Tg but a decreasing trend in CTE as the structure X is changed.

Berikan alasan bagi pola peningkatan dalam nilai Tg dan pola penurunan dalam nilai CTE apabila struktur X diubah.

(44 marks/*markah*)

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